PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

High Efficiency Engines and Turbines

12/2002

DUAL FUEL ISSUES RELATED TO PERFORMANCE, EMISSIONS AND COMBUSTION INSTABILITY IN GAS TURBINE SYSTEMS

PRIMARY PARTNER

Pennsylvania State University

TOTAL ESTIMATED COST

$ 450,000

CUSTOMER SERVICE

800-553-7681

STRATEGIC CENTER FOR NATURAL GAS WEBSITE

www.netl.doe.gov/scng

Description

Under this Advanced Gas Turbine Systems Research (AGTSR) program, Penn State is conducting experiments with natural gas and hydrocarbon liquid turbine fuels using a combustor that operates under conditions, in terms of temperatures and pressures, that simulate gas turbines. Figure 1 illustrates the combustor. The optical access capabilities of this combustor have been demonstrated to enable in-situ measurements of energy release, mixing conditions, and chemical species under dynamic pressure oscillation conditions which are extensively characterized.

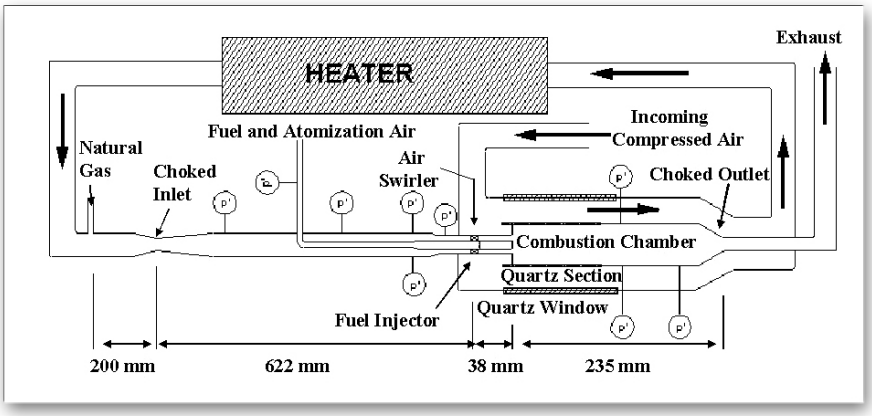

Figure 1. Schematic of Combustor Used for Stability Measurements

Dual Fuel Issues Related to Performance, Emissions and Combustion Instability in Gas Turbine Systems

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Task 1 will evaluate fuel effects on instability and emissions using prevaporized liquid fuels. This series of tests simulates complete fuel atomization and allows liquid fuel properties and degree of premixing effects to be assessed independently of atomization and droplet vaporization effects. Comparison with data from recently completed natural gas experiments in an identical system will provide information on effects of fuel type. Task 2 utilizes an air blast atomizer to inject liquid fuels into a premixer similar to that used in Task 1. Measurements will enable the evaluation of effects of atomization and droplet vaporization on combustion instability behavior. Task 3 will collect data and perform evaluations to determine effects of multi-point fuel injection on performance and combustion instability. Modeling in Task 4 will be used to develop a global understanding of the ways that combustion couples with and influences the evolution of steady and unsteady (oscillatory) flow in combustors. The experimental data and analyses in this project will explore and identify factors that initiate and sustain oscillations, and determine differences for natural gas and petroleum liquid fuel operation.

Duration

36 months

Goals

Capabilities for operation with both natural gas and liquid petroleum fuels offers advantages to gas turbine plants for times when natural gas is not available or when its price is high (e.g., as in early 2001). Low NO_X turbine combustors designed for natural gas fuels have experienced noisy and damaging instabilities and combustor design for dual fuel operation presents even greater challenges. This project conducts combustor experiments and analyses to address the issues related to performance, emissions, and combustion instability for natural gas and liquid hydrocarbon fuels.

Benefits

This project will provide an understanding of effects of liquid fuels versus gaseous fuels on low emission combustor instabilities and performance . An instability database will also be obtained for the gas turbine industry to validate combustor analysis and design models for operation with natural gas and liquid fuels.